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Guide on Life Cycle Inventory (LCI) data generation for the Environmental Footprint

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Abstract

This document provides additional guidance, in addition to the ILCD entry-level requirements[1] (JRC 2012), in order to develop process data sets, compliant with the Environmental Footprint (EF) requirements.

EF compliant Life Cycle Inventory (LCI) data sets shall be compliant with:

- EF ELEMENTARY flows: the nomenclature shall be aligned with the most recent version of the EF reference package available on the EF developer's page at the following link http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml. Details to fulfil this aspect are available in the "ILCD Handbook – Nomenclature and other conventions" (JRC 2010a)[2]
- For the PROCESS data sets and PRODUCT flow, the nomenclature shall be compliant with "ILCD Handbook – Nomenclature and other conventions" (JRC 2010a)

This document provides further details on more specific aspects and procedures related to EF compliant data sets, and is divided in five sections:

1. The definition of the different process data set types allowed in the ILCD Format.
2. The procedure for EF data sets and data stocks[3] updates, describing how to update and document changes in the future releases of EF data sets, replacing older versions with new ones.
3. Harmonization of level – 1 disaggregated data sets, including the intended level of disaggregation for the EF requirements, and the additional documentation needed.
4. Requirements for meta-data information of EF data sets, describing where and how to include the documentation information to fulfil the EF requirements.
5. Reviewer's requirements and review report, including the minimum level of expertise for a reviewer (or a team), in order to be eligible for the EF data set's review, and the review report template, with explanations on how to fill in the different fields.

[1] http://eplca.jrc.ec.europa.eu/uploads/ILCD-Data-Network-Compliance-Entry-level-Version1.1-Jan2012.pdf

[2] http://eplca.jrc.ec.europa.eu/uploads/MANPROJ-PR-ILCD-Handbook-Nomenclature-and-other-conventions-first-edition-ISBN-fin-v1.0-E.pdf

[3] Each node, managed by each data provider, can contain different data stocks with different data, and available under different conditions (e.g. free access, access only to registered users, etc.)

Acknowledgements

The definitions of dataset types, in chapter 1, were drafted by Dr. Marc-Andree Wolf (MaKi Consulting). The overall document has been drafter in collaboration between JRC and DG-ENV.

Introduction

Since 2007, the Joint Research Centre, in collaboration with the DG Environment, developed the International reference Life Cycle Data (ILCD – JRC 2010b) format, and compliance system, responding to several policy needs over years, both at the EU and international level.

In 2013 the "communication from the commission to the European parliament and the council *Building the Single Market for Green Products Facilitating better information on the environmental performance of products and organisations*" (COM/2013/0196) endorsed the creation of the Product and Organisation Environmental Footprint methods (PEF and OEF, respectively, or generically EF) (2013/179/EU).

According to the new needs, and the updated methodological approach, the old ILCD compliance system, as well as the format, the reference packages and the meta data to be used, had to be slightly reviewed.

This document provides additional guidance, beyond the documentation available for ILCD Life Cycle Inventory (LCI) data set development, on how to develop and model LCI data compliant with the EF requirements.

1. Process data set types differentiated in ILCD format [4]

Unit process, single operation

Unit operation type unit process that can not be further subdivided. Covers multi-functional processes of unit operation type.

Additional explanation: This data set type is used exclusively for process steps that cannot be usefully further subdivided in terms of data collection for delivering the functional unit or reference flow. Examples are unit operations or grouped operations in chemical engineering, such as mixing, chemical reactions, crushing, and transport etc., but also machines with either only one function or product output, or - for multifunctional processes - where the co-functions/products all undergo the same processing steps. An injection moulding machine, a truck transport, a catalytic cracker plant at a refinery, and the farming of a crop are concrete examples. "Unit process, single operation" processes are hence undistorted among co-functions (in contrast to many "Unit process, black box") and allow for a more reliable review, even though they may combine more than one technical components and steps (such as in a catalytic cracker plant example).

Unit process, black box

Process-chain or plant level unit process. This covers horizontally averaged unit processes across different sites. Covers also those multi-functional unit processes, where the different co-products undergo different processing steps within the black box, hence causing allocation-problems for this data set. [3]

Additional explanation: Examples are plants and process chains or whole production sites (also called "gate-to-gate" processes) where co-functions/products do NOT all undergo the same process steps, but interim products are taken out, while others are further processed. A classic example is the oil refinery, with e.g. Butane is a product of the first plant, the atmospheric distillation plant, which hence receives very little energy consumption and related emissions, while low-sulphur Diesel or Gasoline are two of the last products that underwent on different routes up to a dozen of plants inside the refinery, with a several times higher energy consumption and emission per product amount. "Unit process, black box", can hence be both vertically aggregated and/or horizontally averaged, are often distorted among co-functions/products and moreover can less reliably be reviewed, given that they combine several processes vertically or horizontally.

[4] http://eplca.jrc.ec.europa.eu/LCDN/downloads/ILCD_Format_1.1_Documentation/ILCD_Common_EnumerationValues.html

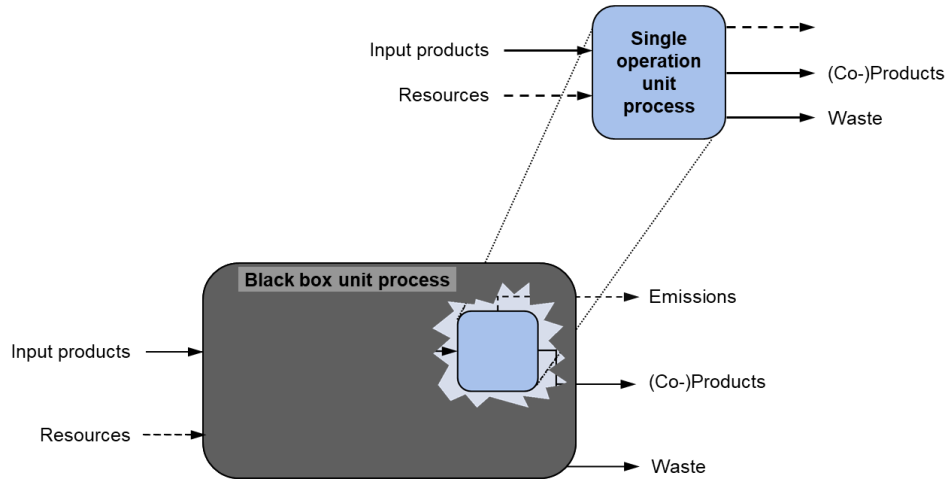

Figure 1. Unit process, single operation vs Unit process, black box (taken from the ILCD handbook – General guide for LCA, figure 7, page 75).

LCI result

Aggregated data set of the complete or partial life cycle of a product system that next to the elementary flows (and possibly not relevant amounts of waste flows and radioactive wastes) lists in the input/output list exclusively the product(s) of the process as reference flow(s), but no other goods or services. E.g. cradle-to-gate and cradle-to-grave data sets. Check also the definition of "Partly terminated system". [3]

Additional explanation: Examples are process nets that include all human upstream activities that transform natural resources into a desired product/function (or functions/products, in case of multifunctional data sets). Such aggregated data sets (also named Ecoprofile, System process) provide the life cycle inventory for the provision of e.g. 1 kg Corn at the farm gate, 1 kWh low voltage electricity delivery to the consumer, 1 m2 wool carpet incl. maintenance and end-of-life treatment, or of 1 1 MW wind power plant of a specific model and installed at the foreseen site. Also end-of-life treatment chains/nets of a defined amount of a defined waste (i.e. waste collection, pre-treatment and treatment such as recycling, energy recovery, landfilling of the remains) are an LCI result data sets, as long as exclusively the to-be-treated waste is the only non-elementary flow. (Note that in all cases, radioactive waste flows and quantitatively irrelevant amounts of other waste flows are allowed to stay in the inventory.)

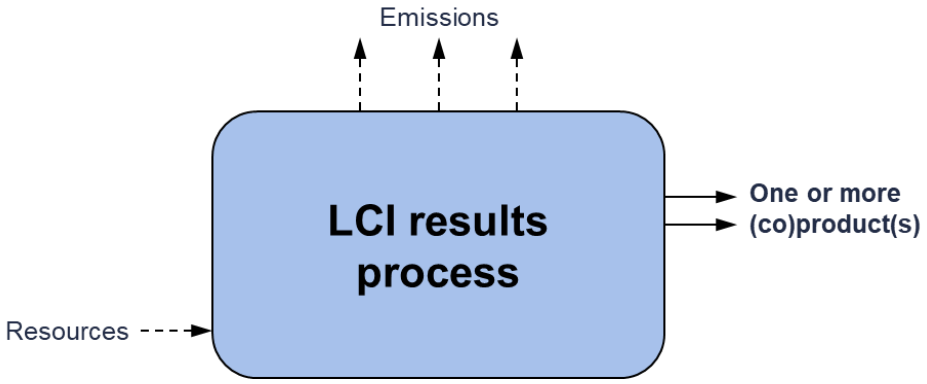

Figure 2. LCI result (Only radioactive waste flows and quantitatively irrelevant others waste flows may remain in the inventory; not shown.)

Partly terminated system

Aggregated data set with however at least one product flow in the input/output list that needs further modelling, in addition to the reference flow(s). E.g. a process of an injection moulding machine with one open "Electricity" input product flow that requires the LCA practitioner to saturate with an Electricity production LCI data set (e.g. of the country where the machine is operated). Note that also aggregated process data sets that include relevant amounts of waste flows for which the waste management has not been modelled yet are "partly terminated system" data sets. [3]

Additional explanation: This data set type is used to provide largely complete (almost) LCI result data sets that require (and allow) to exclusively connect one or a few specific background data sets, while all other upstream (and/or downstream) processes are already included and aggregated. This reduces modelling and review effort and increases reproducibility, while it naturally and intentionally limits other changes to the data set.

Note: this is the data set type to be used for EF "partly disaggregated at level-1".

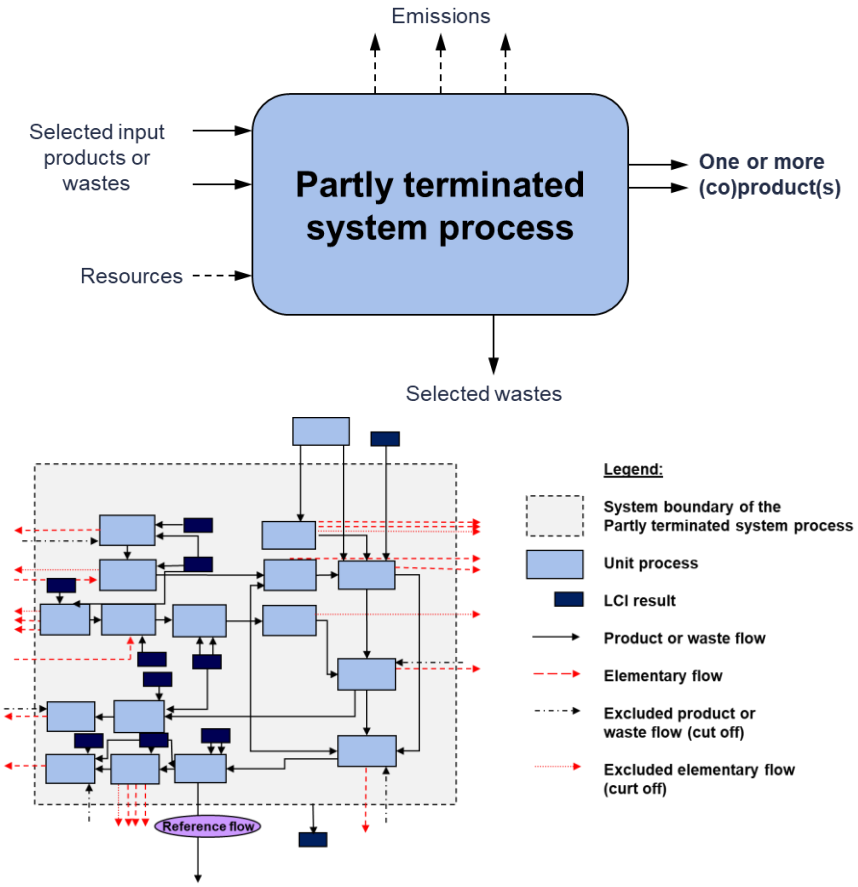

Figure 3. Partly terminated system process (overview, top; detail, illustrative, bottom) with at least one not included product or waste input flow or waste output flow that is still to be modeled to yield a LCI result data set. Note that wastes are sometimes modelled output flow, sometimes as service input flow.

Parameterized data sets	*Data sets in which part or all of the exchange values, scale through some characteristic parameter of the output product or service. Modelling variables, to be detailed in the documentation, in the section "mathematical model".* [3]
	The mathematical relations should represent the relevant changes of the inventory in dependency of the influential parameters, which can be e.g. technical, management, or others. This can include quantitative and qualitative relationships among inventory flows.

2. Procedure for updates of EF data sets and data stocks

All the datasets shall contain the reference to the node they belong to. A source file for each dataset shall be indicated in the process. If a new node is released a specific source file shall be generated. The different data stocks created within the same node, carries the same (node's) source but shall be named starting with the version of the EF reference package they are compliant with (e.g., "EF3.0").

Conditions to update EF data sets and data stocks

The EF data sets and data stocks (i.e. the homogeneous stocks of data set within a node in ILCD or EF registry[5]) shall be updated in the following cases:

Case A) changes in process data sets, not related to changes in the EF reference package[6]

A1- affecting core content* of the data
A2- not affecting the core content* of the data

Case B) changes in the EF reference package that do or do not lead to changes in the core content of the data

**core content is defined as: changes in LCI, DQRs, LCIA Results and process name, or any 'semantic' change in core objects (e.g. change in flow properties, or units etc.).*

For case B, each release of a new EF reference package, from version 3.0 onwards, is accompanied with an executable tool released by the European Commission that automatically converts the data from the previous to the next version of the EF reference package. Furthermore, a change log comparing the different versions of EF reference packages, allows the data developers to know what has changed in different versions, and whether this affects or not the core content of the data set.

Frequency of the updates

The EF reference package may be updated maximum once per year. The data providers are free to upload new data into the nodes they manage, with no limitation in time.

Procedure for updates that affect the core content of the data set (case A1)

The *"Overall change log"* template (available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml) shall be used to summarize all the changes occurred in the entire data stock or an entire data package (a complete release of data sets by a provider) release. The file name of the overall change log shall be the name of the data stock pre-update.

Data set-specific change logs (*"core changes template"* available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml) shall be filled in for each single changed data set, in order to document the changes occurred. The Excel template

[5] See this link for further info: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

[6] The package in ILCD structure provided by the European Commission, that includes reference items such as elementary flows, flow properties, unit groups, methods etc. available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml. Shortly named 'EF package'.

differentiates between main changes (affecting the core content) and 'other' changes (to document minor changes that occurred).

Two exemplary files, for the instructions on how to fill the information in the change logs, are available at:

http://eplca.jrc.ec.europa.eu/PERMALINK/EXAMPLE_OVERALL_log.xlsx

http://eplca.jrc.ec.europa.eu/PERMALINK/EXAMPLE_CORE_CHANGES_log.xlsx

As the core content has changed due to corrections made by the data provider, the new data sets shall: (i) have an updated review (full or partial, i.e. update only the review of the parts that changed), (ii) carry a different UUID, (iii) be hosted on the same data stock[7], and (iv) the superseded data sets shall be linked into the new data set (Under Administrative information > publication and ownership > preceding data set version). The file name of the data set-specific change log shall be the UUID of the data set pre-update. The name of the updated EF data set shall be updated (e.g. with "Updated+year" or other indicators in the name that differentiate the data set from the previous version). The original dataset (pre-update) shall remain available on the node.

The provider shall indicate the changes on the landing page of the node, together with the excel files with the overall + data set-specific change logs (or in a specific repository linked from the landing page). The provider shall register the updated data sets in the EF registry (LCDN - http://lcdn.jrc.ec.europa.eu/EFRegistry/) and notify the EC via the functional email env-environmental-footprint@ec.europa.eu.

Procedure for updates from the data provider that do not affect the core content of the data set (case A2)

In case A2 (no core changes made by the data provider), the updated data sets shall: (i) keep its original UUID, (ii) be hosted on its original data stock, and (iii) have an updated version number. The original dataset (pre-update) shall remain available on the node.

The *"Overall change log"* template (available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml) shall be used to summarize all the changes occurred in the entire data stock or an entire data package release. The file name of the overall change log shall be the name of the data stock.

Procedure for updates due to the EF reference package update (case B)

In case B (any change due to the adaptation to a new EF reference package) the updated data sets shall: (i) keep their original name and UUID, (ii) have an updated version number, and (iii) be hosted into a new data stock. The new data stock shall carry the same name of the previous one, but the name shall start with the reference package+version (e.g. "Energy and Transport" data stock, converted in EF 3.0, shall be stored in a data stock named "EF3.0 Energy and Transport"). The original data sets (pre-update) shall remain available on the node.

The *"Overall change log"* template (available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml) shall be used to summarize all the

[7] If the majority of the data package in the data stock is updated, a new data stock might be necessary and should be used.

changes occurred in the entire data stock or an entire data package release. The file name of the overall change log shall be the name of the data stock.

If the change occurs due to an update of the EF reference package, the data set shall be updated declaring the compliance with the EF reference package (e.g. EF 2.0, EF 3.0 etc) in the field "compliance declaration" within the data set.

The new data stock shall contain the updated processes and mirror the old ones that have not changed (belonging to the same stock). Note that all datasets within the same data stock shall be updated with the same version of the EF reference package and a complete data package shall be provided in each data stock. The provider shall indicate the changes on the landing page of the node, together with the excel files with the general + data set-specific change logs (or in a specific repository linked from the landing page). The provider shall register the updated data sets in the EF registry (LCDN - http://lcdn.jrc.ec.europa.eu/EFRegistry/) and notify the EC via the functional email env-environmental-footprint@ec.europa.eu

3. Harmonization of EF data sets partly disaggregated at level-1

EF data sets shall be provided both as aggregated data sets (type: LCI result) and partly disaggregated at level-1 [8] (type: partly terminated system). Figure 3 provides a graphical representation of what is meant with EF data sets partly disaggregated at level-1.

As a minimum, the central data set shall be aggregated at level 1 with the different inputs and outputs structured as follow (see figure 4):

- Sub-processes for energy: to be modelled as input(s), one single sub-process per energy data set, including any potential energy conversion of fuels and thus direct emissions, as "steam from [name of fuel]", or "process heat from [name of fuel]";
- Sub-processes for transport: to be modelled as input(s), one single sub-process for each transported material/ingredient/component and transport data set entering the gate of the central data set modelled. Meaning, each different transport data set (e.g, lorry euro 4 or lorry euro 5) shall be modelled as a different data set input.
- Sub-processes, in case system expansion is used as allocation: Sub-processes used to model avoided product systems shall be modelled as output(s) and indicate "*Avoided product system*" in the field "*Type of data set*". A dummy process shall be used between the central dataset and the sub-process to convert the positive LCI values of the sub-process to negative values. This is done by linking in the dummy process i) a positive input product flow to the output product flow from the central dataset and ii) a negative input product flow to the output product flow of the avoided sub-process.
- One aggregated sub-process for all remaining processes that represent the background system. (blue box in the figure below), to be modelled as input;
- The output product flow: multiple (non duplicated) output product flows are allowed, but one reference output product flow shall be defined in the field "ReferencetoReference flow". This can be an input or output flow and shall be defined in the data set;
- One sub-process with all direct emissions and resource inputs (e.g., land resources, water resources) of the foreground system constituting the final output product;

[8] The notation „level-1 data set" is also used in this document

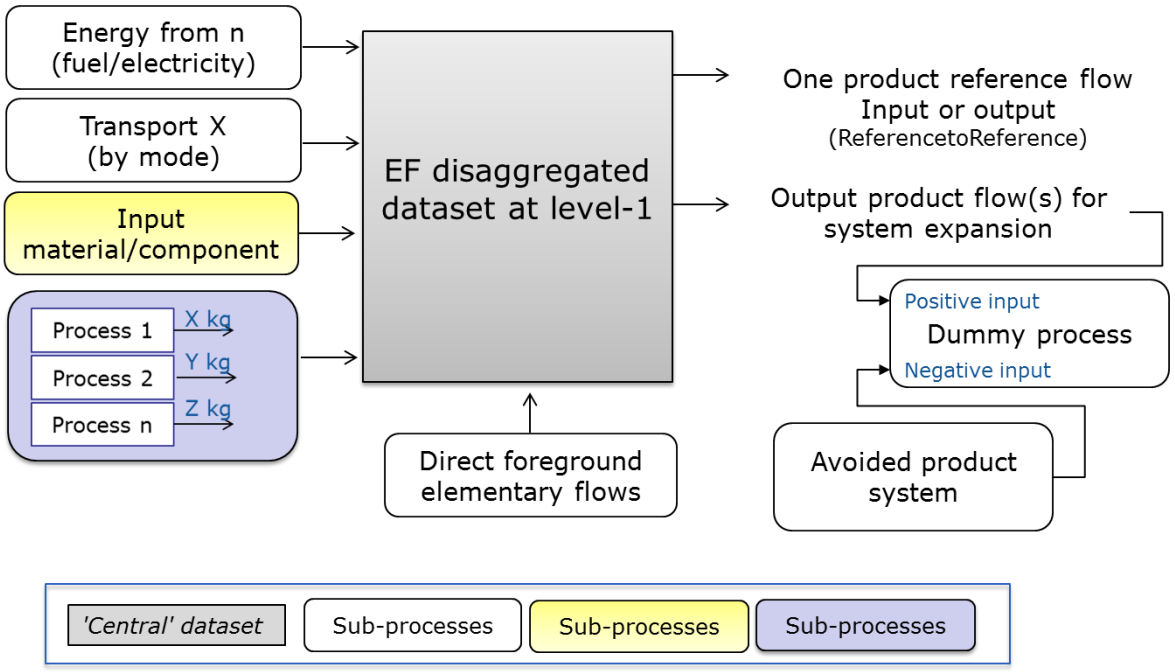

Figure 4. Minimum level of disaggregation requested for a data set disaggregated at level -1. The yellow box is optional when going beyond the minimum requirements. The grey box is named 'central data set'.

Further requirements for level-1 data sets are:

Duplicated input or output elementary flows are allowed. For data set users, the European Commission will provide a tool to merge multiple elementary flows with the same UUID (Universal Unique IDentifier) and same location code. Flows with the same UUID but different locations will not be merged. Multiple product flows will not be merged. The tool will also concatenate the general comments behind the flows (if any), and report in brackets the mean value of each of the original single flows[9].

Duplicated input or output product/waste flows are not allowed[10]. The flow type 'others' shall not be used.

The European Commission is working on the development of the Extended-ILCD (eILCD) format toallow to properconnections between the product flows in the central data sets and the related sub-processes. Once the new format will be available, additional documentation will be provided..

[9] Note for the data set provider of duplicated elementary flows, the concatenated comment field has a limit of 500 characters and everything beyond that limit is cut off. Therefore the length of comments in duplicated flows shall be limited, and ideally be about 450 characters (to leave space for the amounts) divided by the number of flows to be merged.

[10] Duplicated (i.e. more than one entry exchange with the same UUID) input or output PRODUCT and waste flows are not allowed. This condition will be re- evaluated by the EC after 2020.

4. Requirements for meta-data information in EF data sets

General information

This section provides binding requirements on the meta-data information in EF data sets. These are in addition to the ILCD-Entry Level requirements.The ILCD data format documentation contains detailed descriptions of the individual format fields and is available online at http://eplca.jrc.ec.europa.eu/LCDN/developerILCDDataFormat.xhtml. This documentation shall be used to avoid mistakes in data filling such as exceeding the number of allowed characters or setting a wrong value in a field. Unless specific guidance is given below, please refer to the definitions and explanations given there.

This chapter is divided in three sections:

1. Information relevant for all data sets
2. Additional information relevant for disaggregated data sets
3. Information to be provided in supporting sub-processes

Conventions

Type of data set refers to a field in the ILCD data format.

Value from enumerated list refers to a value from an enumerated list for a specific format field, i.e. the entry is to be selected from a predefined and fixed list of possible entries.

Free text value refers to a free text value for a specific format field

Information relevant for all data sets

Data set LCA report, background info

In the field *Data set LCA report, background info*, if a PEF study is performed, the PEF report shall be referenced.

Type of process

The available options for the field *Type of data set* are explained in detail in chapter 1"Process data set types differentiated in ILCD format**".**

Specifically in the EF context, for aggregated data sets, use *LCI result*, and for partly disaggregated data sets, use *Partly terminated system*.

Reference year

From the ILCD data format specification: "Start year of the time period for which the data set is valid (until year of 'Data set valid until:'). For data sets that combine data from different years, the most representative year is given regarding the overall environmental impact. In that case, the reference year is derived by expert judgment." The reference year shall not be changed for data set updates (i) due to a change in EF package or (ii) that do not affect the LCI content.

Default parameter values

For parameterized data sets, the respective default value shall be given for each parameter (e.g., the utilization ratio in transport data sets) in the *Comment, units, defaults* field within the *Mathematical model* section.

Regionalized elementary flows

All locations are allowed for modelling of elementary flows in the impact categories Land Use and Water Use. In all other cases, regionalization is only allowed for substances and countries reported in annex I.

Duplicated elementary flows

Duplicated elementary input/output flows are allowed. The source of the flow **shall** be documented in the comment field next to the duplicated flows.

Allocation

The allocation methods listed in *LCI method approaches* should reflect those used for both the foreground system and background systems. In the corresponding explanation field *Deviations from LCI method approaches / explanations* detailed information shall be given, indicating separately the allocation used in the foreground and background system.

Element content

The water content and the biogenic carbon content at factory gate (physical content) shall be reported only if different from zero. **If derived from native forest, it shall report that the corresponding carbon emissions shall be modelled with the elementary flow ending with 'Land use change'.** This information characterizes the product (and not the process). Therefore, it needs to be stored in the reference flow (which is a product or waste flow) by means of individual flow properties. The element content is modelled by referencing the corresponding flow property (e.g. "carbon content") and giving a value (which corresponds to that flow property's reference unit, which usually should be kg) in the flow data set that represents the product flow (see Figure 5). The example below shows the relationships for a product flow with a carbon content of 0.43 kg and a water content of 0 kg.

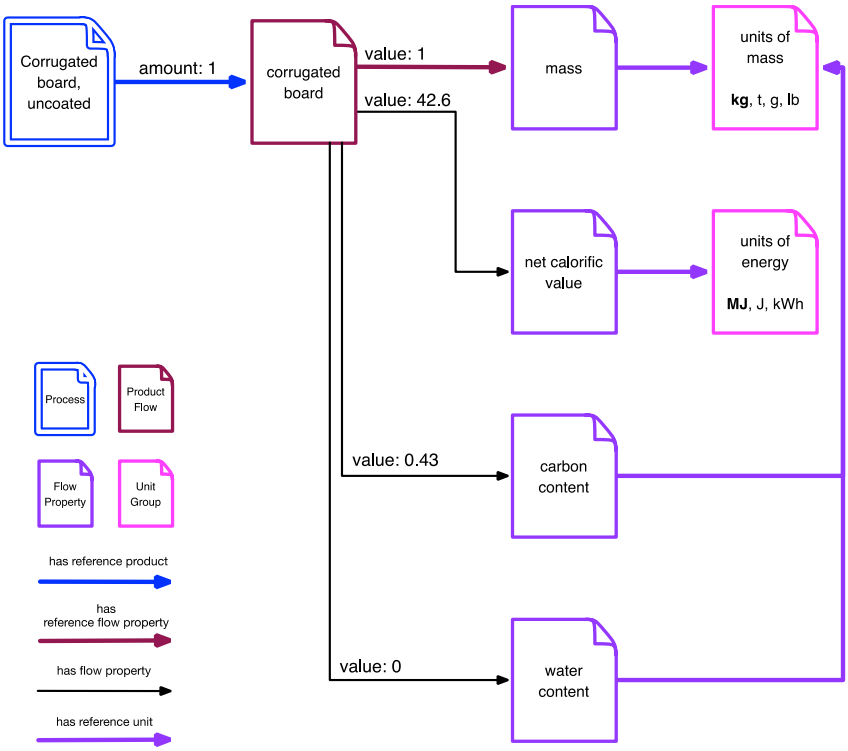

Figure 5. Modelling element content

In the actual data set displayed on the node, the reference flow is always available as a hyperlink as shown in **Error! Reference source not found.**.

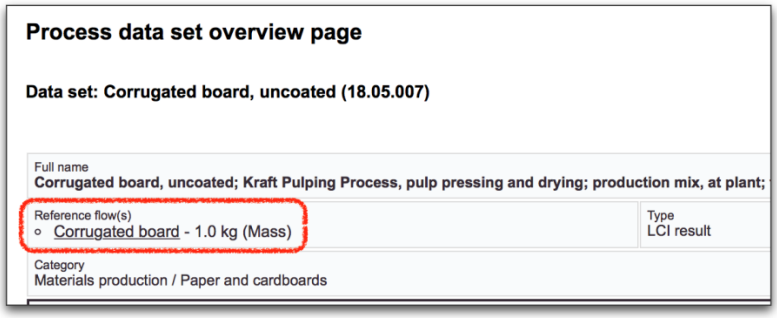

Figure 6. Hyperlink to the reference flow in the process data set

When following this link, the product flow data set can be inspected, which in addition to its mandatory reference flow property can have an arbitrary number of additional flow properties, as shown in figure 7. In this case biogenic carbon and water contents are declared.

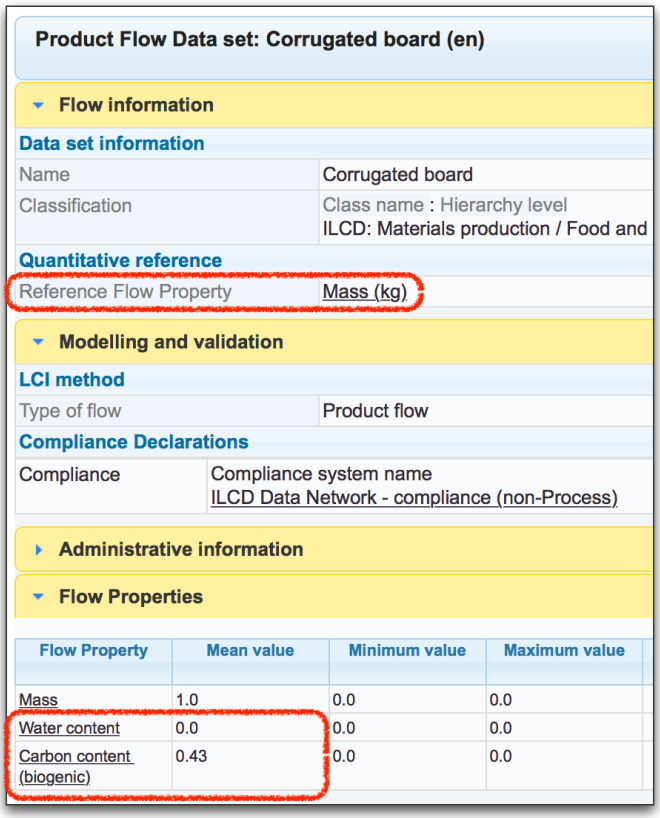

Figure 7. Element content flow properties in a product flow

CFF Parameters

The Circula Footprinf Formula (CFF) parameters used shall be provided in the existing field *Deviations from LCI method approaches / explanations* as textual description. It shall be defined where the CFF has been applied. The CFF parameters shall be reported unless they are zero (e.g., R1=0) and the landing page shall provide a general documentation that parameters not documented are equal to zero.

Modelling constants

The field *modelling constants* shall indicate as a minimum how biogenic carbon has been modelled, if emission off-setting is applied and if capital goods are excluded.

LCA methodology report

The source data set of the most recent PEF method shall be referenced in the field *LCA methodology report*. If relevant, also the source data set of the applicable PEFCR shall be referenced.

Data sources used for this data set

In the field *Data sources used for this data set* the EF data packages plus the data source(s) used for gap filling data sets are to be referenced. Each shall be referenced as one source data set with the respective data package node/weblink.

Reference to supported Impact methods:

Add exclusively and individually references/hyperlinks to the source data sets of the EF impact categories applied.

Compliance

A reference to the compliance system "PEF/OEF implementation, mandatory data 2016-2020" (source data set with UUID 66279383-8dc3-46c1-80d1-99866cc01e6a) shall be given under *Compliance*.

In addition, a reference to the EF reference package version used in the data set shall be given, using the corresponding source data set. The EF reference package source data set will be provided with each EF reference package releases (source data sets with classification "Compliance systems").

LCIA results

The LCIA results shall be reported in the *LCIA results* section, for all the EF impact categories at the end of the XML structure, in process data sets. They shall be written as scientific notation.

Data quality criteria and rating

The DQR of a data set shall be calculated based on the equation F.1[11]:

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\overline{P}}{4} \qquad \text{[Equation F.1]}$$

Where TeR is the Technical Representativeness, G_R is the Geographical Representativeness, Ti_R is the Time Representativeness and P is the Precision. The representativeness (technological, geographical and time-related) characterises to what degree the processes and products selected are depicting the system analysed, while the precision indicates the way the data is derived and related level of uncertainty.

The DQR shall be calculated before any aggregation of sub-processes or elementary flows is performed. In particular, the procedure shall be applied before the creation of the aggregated sub-process of the level-1 disaggregated data set (the "blue box" in). For secondary data sets (e.g., developed by database providers) the following procedure applies:

1) Select the most relevant sub-processes and direct (foreground) elementary flows that account for at least 80% of the total environmental impact of the secondary data set, listing them from the most contributing to the least contributing one;

[11] The EF data sets tendered during the pilot phase might apply a different approach, like expert judgement. The approach used is clarified in the respective data set meta data information.

2) Calculate the DQR criteria Te_R, Ti_R, G_R and P for each most relevant process and each most relevant direct elementary flow. The values of each criterion shall be assigned based on Table.

2.a) Each most relevant elementary flow consists of the amount and elementary flow naming (e.g. 40 g carbon dioxide). For each most relevant elementary flow, evaluate the 4 DQR criteria named $Te_{R\text{-}EF}$, $Ti_{R\text{-}EF}$, $G_{R\text{-}EF}$, P_{EF}. For example, evaluate the timing of the flow measured, for which technology the flow was measured and in which geographical area.

2.b) Each most relevant process is a combination of activity data and the secondary data set used. For each most relevant process, the 4 DQR criteria are calculated as follow: (i) Ti_R and P shall be evaluated at the level of the activity data (named $Ti_{R\text{-}AD}$, P_{AD}), while (ii) Te_R, Ti_R and G_R shall be evaluated at the level of the secondary data set used (named $Te_{R\text{-}SD}$, $Ti_{R\text{-}AD}$ and $G_{R\text{-}SD}$). As Ti_R is evaluated twice, the mathematical average of the activity data and secondary data set represents the Ti_R of the most relevant process.

3) Calculate the environmental contribution of each most-relevant process and elementary flow to the total environmental impact of all most-relevant processes and elementary flows, in % (weighted using 13 EF impact categories, with the exclusion of the 3 toxicity-related ones). For example, the newly developed data set has only two most relevant processes, contributing in total to 80% of the total environmental impact of the data set:

- Process 1 carries 30% of the total data set environmental impact. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).
- Process 2 carries 50% of the total data set environmental impact. The contribution of this process to the total of 80% is 62.5% (the latter is the weight to be used).

4) Calculate separately the Te_R, Ti_R, G_R and P for the secondary data set as the weighted average of each criteria of the most relevant sub-processes and most relevant direct elementary flows. The weight is the relative contribution (in %) of each most relevant process and direct elementary flow calculated in step 3.

5) Calculate the total DQR of the secondary data set using equation I.1, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \overline{P}$ are the weighted averages calculated as specified in point 4. In order to be EF compliant, each single criteria in cannot be higher than 3.0.

Table1: Quality rating for the data quality criteria

Quality rating	P_{EF} and P_{AD}	Ti_{R-EF} and Ti_{R-AD}	Ti_{R-SD}	Te_{R-EF} and Te_{R-SD}	G_{R-EF} and G_{R-SD}
1	Measured/calculated and verified	The data (collection date) can be maximum 2 years old with respect to the "reference year" of the data set.	The "reference year" of the tendered data set falls within the time validity of the secondary data set	Technology aspects have been modelled exactly as described in the title and metadata, without any significant need for improvement	The processes included in the data set are fully representative for the geography stated in the "location" indicated in the metadata
2	Measured/calculated/literature and plausibility checked by reviewer	The data (collection date) can be maximum 4 years old with respect to the "reference year" of the data set.	The "reference year" of the tendered data set is maximum 2 years beyond the time validity of the secondary data set	Technology aspects are very similar to what described in the title and metadata with limited improvements. For example: use of generic technologies' data instead of modelling all the single plants.	The processes included in the data set are well representative for the geography stated in the "location" indicated in the metadata
3	Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer	The data (collection date) can be maximum 6 years old with respect to the "reference year" of the data set.	The "reference year" of the tendered data set is maximum 3 years beyond the time validity of the secondary data set	Technology aspects are similar to what described in the title and metadata but merits improvements. Some of the relevant processes are not modelled with specific data but using proxies.	The processes included in the data set are sufficiently representative for the geography stated in the ""location" indicated in the metadata. E.g. the represented country differs but has a very similar electricity grid mix profile,
4	Qualified estimate based on calculations, plausibility not checked by reviewer	The data (collection date) can be maximum 8 years old with respect to the "reference year" of the data set.	The "reference year" of the tendered data set is maximum 4 years beyond the time validity of the secondary data set	Technology aspects are different from what described in the title and metadata. Requires major improvements.	The processes included in the data set are only partly representative for the geography stated in the "location" indicated in the metadata. E.g. the represented country differs and has a substantially different electricity grid mix profile
5	Rough estimate with known deficits	The data (collection date) is older than 8 years with respect to the "reference year" of the data set.	The "reference year" of the tendered data set is more than 4 years beyond the time validity of the secondary data set	Technology aspects are completely different from what described in the title and metadata. Substantial improvement is necessary	The processes included in the data set are not representative for the geography stated in the ""location" indicated in the metadata.

Ti_{R-EF}: time representativeness for the elementary flow
Ti_{R-AD}: time representativeness for the activity data
Ti_{R-SD}: time representativeness for the secondary data set

How to report the DQR for the data sets: The data set shall state as meta-data one numerical value for each DQR criteria (namely $\overline{Te_R}$; $\overline{G_R}$; $\overline{Ti_R}$; $\bar{P}$) and the total DQR numerical value, always referred to the data set. Data quality shall be provided as text and numbers. The DQR numbers shall be presented as two digits, for the 4 individual criteria Technical Repr., Geographical Repr., Time Repr. and Precision in the field *Data quality indicators*, under *Validation* main field. Methodological appropriateness and completeness shall be set as **"*Not applicable*".**

Information relevant for partly disaggregated data sets

In partly disaggregated data sets (which refers to the central level-1 processes, but not the other complementing/supporting processes), the following additional information is to be reported in addition the information listed above:

Complementing processes

With the format specific field *Complementing processes*, all/only the central dataset's sub-processes shall be referenced. The UUID and exact name of the complementing process shall be specified.

Complete flow diagram

An additional flow diagram of the model with all sub-processes and their physical relationships (what is linked to what and in which direction, as input or output), as well indicating the system boundaries for the data set shall be provided as a graphic. This graph shall be linked in addition (not replacing the activities' flow diagram) under *Flow diagramm(s) or picture(s).* The aim is to make it clear for the user which emissions and activities are included in the respective data set and which are not.

A generic template for designing in addition a systematic system boundary diagram is provided in the ILCD Handbook: Specific guide for Life Cycle Inventory (LCI) data sets, Annex E. The use of the template is recommended but not mandatory, other forms can be used as long as all included and excluded Life Cycle stages, activities, processes and flows are identified.

Supporting sub-processes

Disaggregated data set may contain the following types of complementing sub-processes:

- EF compliant sub-processes (EF complaint secondary data sets from any source, in aggregated or disaggregated form)[12]
- ILCD Entry Level compliant sub-processes (ILCD Entry level compliant secondary data sets from any source, in aggregated or disaggregated form) [1]
- Supporting sub-processes

This section covers the supporting sub-processes. These are:

- processes used to structure the model, like life cycle stages or transport mixers, OR they are a combination of several materials and consumables that are processed in the central level-1 process, OR they are the direct emissions of the central level-1 process
- They are not EF compliant and cannot be used as stand-alone
- They don't have to be reviewed or carry a DQR

[12] this covers both EF secondary data sets and user-developed, other EF compliant data sets, including both unit processes and aggregated LCI results

- They are specifically tied to and shall only be used with their corresponding data set, as part of the disaggregated model

It is important for third parties to be able to identify these data sets, as they must not be used directly and in any other context except together with their corresponding data set. Therefore, the following meta-data information shall be provided:

1. The following meta data fields shall be filled in with the exact information copied from the central level-1 data (see figure 6 in chapter 3) set:
   - *Owner of data set*
   - *Commissioner of data set*
   - *License type*
   - *Access and use restrictions*

2. The field *Use advice for data set* shall contain the following text:

   "This data set is a supporting sub-data set and must be used exclusively as sub-data set of its corresponding level-1 partly disaggregated data set (see "General comment" field for exact name and UUID)."

3. In order for other software systems to be able to identify the supporting sub-data set as such, the following compliance system (source data set) is to be linked under *Compliance declarations* **in the supporting sub-data set**:

   Source data set:

   "Environmental Footprint non-primary supporting data set"

   UUID 2f8a3ebd-befc-4ea9-a6de-34bb6d426d2f available at …

   (will be made available online and via EF reference package)

4. The field *Workflow and publication status* shall be set to *Data set finalised; entirely published*.

5. **"General comment":** *"This data set shall exclusively be used with its full life cycle model of the representative product [fill in name and UUID of the life cycle model dataset] dataset. For DQRs, review reports and other documentation, please see this corresponding dataset."*

5. Reviewer requirements for Environmental Footprint process data sets and review report template

Eligibility

Reviewer's requirements are used to assess the eligibility of reviewers and are automatically applied in the Reviewer Registry (http://eplca.jrc.ec.europa.eu/ResourceDirectory/), accessible through the European Platform on Life Cycle Assessment http://eplca.jrc.ec.europa.eu/). The registry allows the selection of specific requirements, including the Environmental Footprint (for critical review) and ILCD Entry Level (EL) requirements (JRC-2016)[13]. The Reviewer's Registry can be used for the selection and the eligibility assessment of the reviewers.

The minimum requirements for reviewer's eligibility adopted for the ILCD-EL requirements[14], are to be applied for the review of EF Data sets (see table 2).

Table 2. Minimum requirements for reviewer's eligibility in the EF and ILCD-EL compliance. The reviewer skills can also be fulfilled by a team (e.g. one of the reviewer fulfils the minimum requirements for LCA experience and another one the sector-specific minimum requirement).

		ILCD EL
Verification and audit practice	Years of experience [1]	> 2
	Number of reviews [2]	> 2
LCA methodology and practice	Years of experience [3]	> 2
	Participation in LCI work [4]	> 4
Knowledge of technologies or other activities, per sector covered [5]		
NACE main sector	Years of experience in public and/or private organisations	> 2

[1] Experience in auditing and review in the environmental field not only LC-based; [2] As reviewer, LCA (ISO, ILCD or EF compliant) or EPDs or LCI data sets, other LC-based requirements; [3] Starting from Master's degree if mainly focused on LCA; [4] Development/modelling of LCI data sets (documented); [5] Experience by specific macro sector (NACE), at any level (work, monitoring, management, R & D, etc.); [6] In the PEF requirements, the scoring system starts from zero, and for each mandatory field a range of years of experience or skills required is defined, which corresponds to 'no score' or value zero. NB in the PEF/OEF Requirements the score 1, is essentially starting with a + 1 (year or skill) in all the considered mandatory fields, thus, the new ILCD-EL is slightly less stringent than the 'Score 1' Threshold in the PEF/OEF Requirements.

[13] Review schemes and reviewers' selection criteria in the Life Cycle Data Network framework, and at global level http://publications.jrc.ec.europa.eu/repository/bitstream/JRC104639/lbna28277enn.pdf

[14] A set of minimum requirements for reviewers under the EF scheme (both as single reviewers or reviewers' teams) are also described in the Recommendation 2013/179/EU, however this defines the scoring system for CRITICAL review (chapter 9), thus the EF eligibility in the Reviewer Registry refers to that scheme.

Reviewer types

As regards the relationship of the reviewer/team with the data developer or provider, the following cases can be identified:

- **Independent external reviewer/team**: the reviewer shall not be involved in the definition or development of the reviewed case. This includes both the reviewer as a person and the employer (if any) as an organisation. The person or team has to be external, and without relevant relations for at least 1 year to any organisation that performed, commissioned, financed or otherwise had relevant influence on the study to be reviewed. The phrase 'relevant relations' includes financial (beyond the agreement for the review itself and other reviews in the same framework, which are of course allowed), legal or similar ties that would result in a conflict of interest such as subsidies, joint-venture partners, development partners, sales partners, or any other strategic cooperation partners.
- **Independent internal reviewer/team**: the reviewer shall not be involved in the study to be reviewed, or quantitatively relevant parts (e.g. background data) but can be part of the organisation that performed or commissioned the LCA work (or related third party organisations).
- **Dependent internal reviewer/team**: the reviewer can be involved in the study to be reviewed, or quantitatively relevant parts (e.g. background data) and part of the organisation that performed or commissioned the LCA work. This type of reviewer is defined by ISO standard, but is not eligible in the schemes considered in this report.

Five different review types are identified according to the type of reviewer and composition of the review team (see table 3)[15]. **In the EF requirements only the first two cases are allowed**

Table 3. Type of review allowed following the EF scheme (the term "reviewer" refers to a single reviewer or a team, each fulfilling the minimum requirements mentioned above)

Typology and number of reviewers	Type 1	at least 3 independent reviewers, with at least 1 external
	Type 2	Two independent reviewers, with at least 1 external
	Type 3	Two independent internal reviewers
	Type 4	One independent external reviewer
	Type 5	One independent internal reviewer

[15] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC104639/lbna28277enn.pdf

Requirements for the review reports

Under the EF requirements a review report is mandatory for all types of review (see table 3). The detailed review report template presented in Tables 4 shall be filled in by the reviewer/ team. The report shall be attached to the data set on the node under the field "complete review report" (within the validation table) and made visible in the EF registry of the Life Cycle Data Network. Only one review report per data set is allowed, together with its single DQR, agreed upon and signed off by the reviewer or the reviewer team in case of multiple reviewers

In Table 4, all review compliancy aspects shall be answered with "Yes" or have to be fulfilled to claim EF compliancy. In case these items are answered with "no", the data set shall be improved to remove the non-compliances.

If a data set is updated in core content (i.e. LCI, DQRs, LCIA results etc.) a partial review on the new content of the data set is required to be compliant.

A review report template will be available at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtm

Table 4. EF review report template, with comments. Comments and suggestion on how to fill in the different fields are reported in italic.

REVIEW REPORTING			
General information			
Data set name	*Name of the data set, e.g. Electricity grid mix 1 kV-60 kV; AC; consumption mix, at consumer; 1 kV-60 kV*		
Data set UUID and version number	*Unique Identifier (UUID) of the data set (the filename is a 36 digits alphanumeric code with the following structure xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx*		
Data set locator (e.g. Permanent URI, URL, contact point, or database name and version, etc.)	*Permanent URI, URL, contact point, or database name and version, etc.*		
Review commissioner(s)	*Owner of the data set or data set/ database developer or supplier*		
Reviewer name(s) and affiliation(s), contact			
Review type applied, and compliance with EF requirements for review	*Fill in the reviewer type (see table 3)*		
Method used for review , and review scope	*Description of the method adopted to perform the review: e.g. for review of a large number of data sets, specify if each data set has been reviewed by checking each single data point, or if the underlying general model was reviewed + spot check of some parameters in all data sets, or + spot check of all parameters in x% of data sets, etc.*		
Date of review completion	(DD/MM/YYYY)		
Reviewed against/Compliance system name	***PEF/OEF***		
Compatibility with EF reference package (Version)	***Declare the version of EF reference package used***		
OVERALL COMPLIANCE ASSESSMENT			
aspect	**yes**	**no**	**comments**
Compliance with specific EF requirements			*The data set is compliant with all requirements of the reference documents (e.g. reference PEFCR, PEF Guide, PEFCR Guidance). The documentation is complete and clearly describes how the requirements have been applied in the data set (e.g. agricultural modelling, transport, electricity, etc. see Chapter 7 of the PEFCR Guidance)*
Allocation rules clearly explained and consistent			*Allocation applied in the foreground system is clearly explained and documented (type of allocation (mass, economic,…); allocation factors,..)*
(Circular Footprint Formula (correct implementation)			*Check the use of appropriate parameters values. Check point of substitution. Check assumptions for E*v. UUID of data sets used to model the emission profiles of the different parameters are reported.*

			Documentation describing the implementation of the CFF and parameters used is clear with respect to the above checks.
LCIA results consistency			*Compare the LCIA results inside the data set(s) with the results calculated with Look@LCI[16]. Discrepancies >1% are not EF Compliant.*
Nomenclature			
Correctness and consistency of applied nomenclature (use of Specific EF reference package; Correct nomenclature of other flows, processes etc;)			
Documentation			
Appropriateness of documentation (see Document 'Documentation of LCA data sets[17]'), and additional EF guidance above	*Documentation is or not EF compliant (content-wise)? It enables a fair appraisal of the data set or not? Which information are detailed? Which are lacking (if any)? Metadata are detailed enough and respecting ILCD entry-level and additional EF requirements?*		
Appropriateness / correctness of documentation form (ILCD Format)	*The ILCD format is respected? The document has been validated with the Validation Tool? The uncompliant aspects (if any) have been solved? (in order to share data through the LCDN the data package has to be submitted in correct ILCD format).*		
Validation with ILCD validator			*If "no", indicate which aspects are not compliant*
DQRs			*the reviewer takes the responsibility of the DQR declaration. Only one DQR per data set and expressed with two digits (X.X)[18] it can be either calculated by the reviewer of the developer, but the reviewer certifies the correctness of the values*
Cut-off	*Verify the compliance with PEFCR guidance on the cut-off rules applied in the model*		

Additional Information can be added if needed.

Documents referred or accessed by the reviewer (either public or confidential) shall be added as references.

The reviewer shall close and sign the review report with an EF compliancy declaration: "The reviewer(s) declares on his responsibility that the reviewed data set is compliant with the Environmental Footprint general and specific compliance rules."

[16] Calculation tool developed by JRC and available with user instructions at http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml

[17] JRC 2011 http://eplca.jrc.ec.europa.eu/uploads/ILCD-GuidanceDocumentationLCADatasets-Version1-1Beta-2011-ISBN-clean.pdf

[18] To be calculated with 4 criteria (Technical Repr., Geographical Repr., Time Repr. and Precision). The methodological appropriateness and completeness shall be set to 'Not applicable'.

References

2013/179/EU: Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations.

COM/2013/0196 - COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL Building the Single Market for Green Products Facilitating better information on the environmental performance of products and organisations /* COM/2013/0196 final */

JRC 2101a - European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - Nomenclature and other conventions. First edition 2010. EUR 24384 EN. Luxembourg. Publications Office of the European Union; 2010

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JRC 2016 - European Commission - Joint Research Centre – Directorate D - Fazio S. Review schemes and reviewers' selection criteria in the Life Cycle Data Network framework, and at global level; EUR 28277 EN doi:10.2788/573305 Luxembourg: Publications Office of the European Union, 2016

List of abbreviations and definitions

CFF Circular Footprint Formula
DQR – Data Quality Rating
EF – Environmental Footprint
ILCD – International Life Cycle Data system
ILCD–EL - International Life Cycle Data system – Entry Level Requirements
LCI – Life Cycle Inventory
LCIA – Life Cycle Impact Assessment
OEF – Organisation Environmental Footprint
PEF – Product Environmental Footprint
UUID – Universally unique identifier

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ANNEX I allowed regionalized elementary flows

Beyond the flows related to Land Use and Water Use, for which all the global location (country) codes are allowed, the regionalization is also possible for the following substances and UUIDs, and only for the specified location codes

Table 5. Flows, beyond water use and land use where the regionalization is allowed

08a91e70-3ddc-11dd-96ae-0050c2490048	ammonia
2905c64e-6556-11dd-ad8b-0800200c9a66	ammonia
08a91e70-3ddc-11dd-a2aa-0050c2490048	ammonia
08a91e70-3ddc-11dd-a2a9-0050c2490048	ammonia
08a91e70-3ddc-11dd-96af-0050c2490048	ammonia
08a91e70-3ddc-11dd-96e5-0050c2490048	nitrogen dioxide
08a91e70-3ddc-11dd-96e6-0050c2490048	nitrogen dioxide
08a91e70-3ddc-11dd-96e7-0050c2490048	nitrogen dioxide
08a91e70-3ddc-11dd-96e8-0050c2490048	nitrogen dioxide
08a91e70-3ddc-11dd-96e9-0050c2490048	nitrogen dioxide
191b44d4-90c9-465a-8802-93a651b4fd52	Nitrogen oxides
1c952836-ea05-43db-9063-0c5e1ee65fa8	Nitrogen oxides
2f89fbbd-e428-4de1-8c33-9dd66e53310c	Nitrogen oxides
e575ebc3-0a3b-4c38-9a2a-13e42c72553b	Nitrogen oxides
f79d0f8f-2b0e-49cb-bed0-b1ea0fbd8625	Nitrogen oxides
fe0acd60-3ddc-11dd-ac49-0050c2490048	sulfur dioxide
fe0acd60-3ddc-11dd-ac48-0050c2490048	sulfur dioxide
fe0acd60-3ddc-11dd-ac4c-0050c2490048	sulfur dioxide
fe0acd60-3ddc-11dd-ac4b-0050c2490048	sulfur dioxide
fe0acd60-3ddc-11dd-ac4a-0050c2490048	sulfur dioxide
2905c636-6556-11dd-ad8b-0800200c9a66	sulfur oxides
fe0acd60-3ddc-11dd-a208-0050c2490048	sulfur oxides
fe0acd60-3ddc-11dd-a207-0050c2490048	sulfur oxides
fe0acd60-3ddc-11dd-a20a-0050c2490048	sulfur oxides
fe0acd60-3ddc-11dd-a209-0050c2490048	sulfur oxides

Table 6. Location codes allowed for the above mentioned flows

AL	DE	HU	NO
AT	DK	IE	PL
BA	EE	IT	PT
BE	ES	LT	RO
BG	FI	LU	RU
BY	FR	LV	SE
CH	GB	MD	SI
CS	GR	MK	SK
CZ	HR	NL	UA

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